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(54) Electrical adaptor

(57) The adaptor 20 provides a flameproof seal between LNG in a pressure vessel 12 and an electrical coupler 22 without nitrogen purging. Pins in the adaptor are connected to phase conductors 40 leading to an electric drive motor 16 of a submerged pump 14. The coupler connectors engage the opposite ends of the pins. Normal minimal leakage of LNG past primary O-ring seals passes out of the adaptor to atmosphere via a breather vessel 42. Excessive leakage causes pressure at an orifice restriction 127 and a pressure-responsive means responds to trip a circuit-breaker 28 to isolate the supply 26. A similar adaptor 54 can be used at the main tank 10. A valve means 44 allows testing and calibration. A second outlet is directly connected to a breather vessel 42 and passes any leakage past secondary seals to atmosphere.

The adaptor 20 comprises a housing containing a body of electricity insulating material through which at least one conductor extends. Seals 76, 78 exist between the housing and insulating material and seals 108, 110 exist between the conductor(s) and the insulating material. Passages 118 couple gas leakage past seals 108 to an annular passage 116 which receives gas which leaks past seal 76. The passage 116 is coupled to atmosphere.

FIG.1.

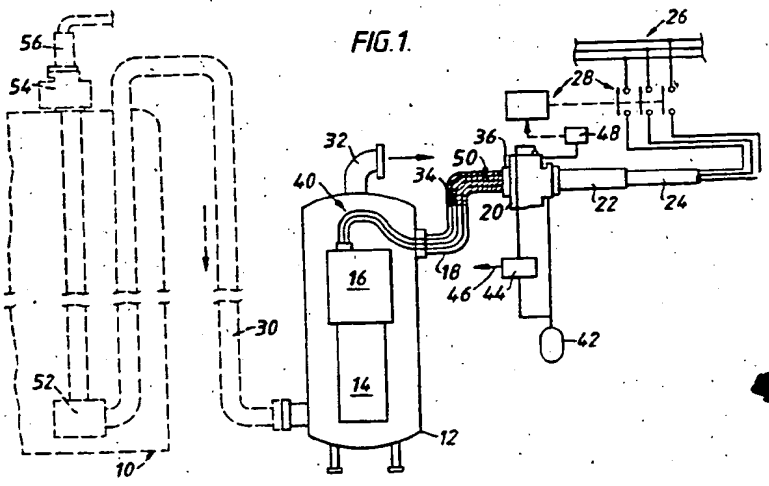
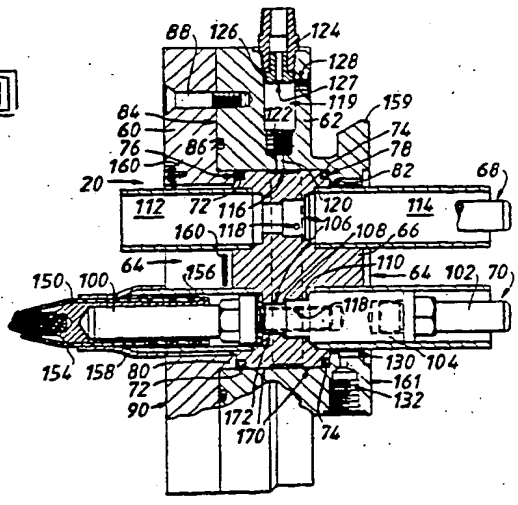


FIG.3.



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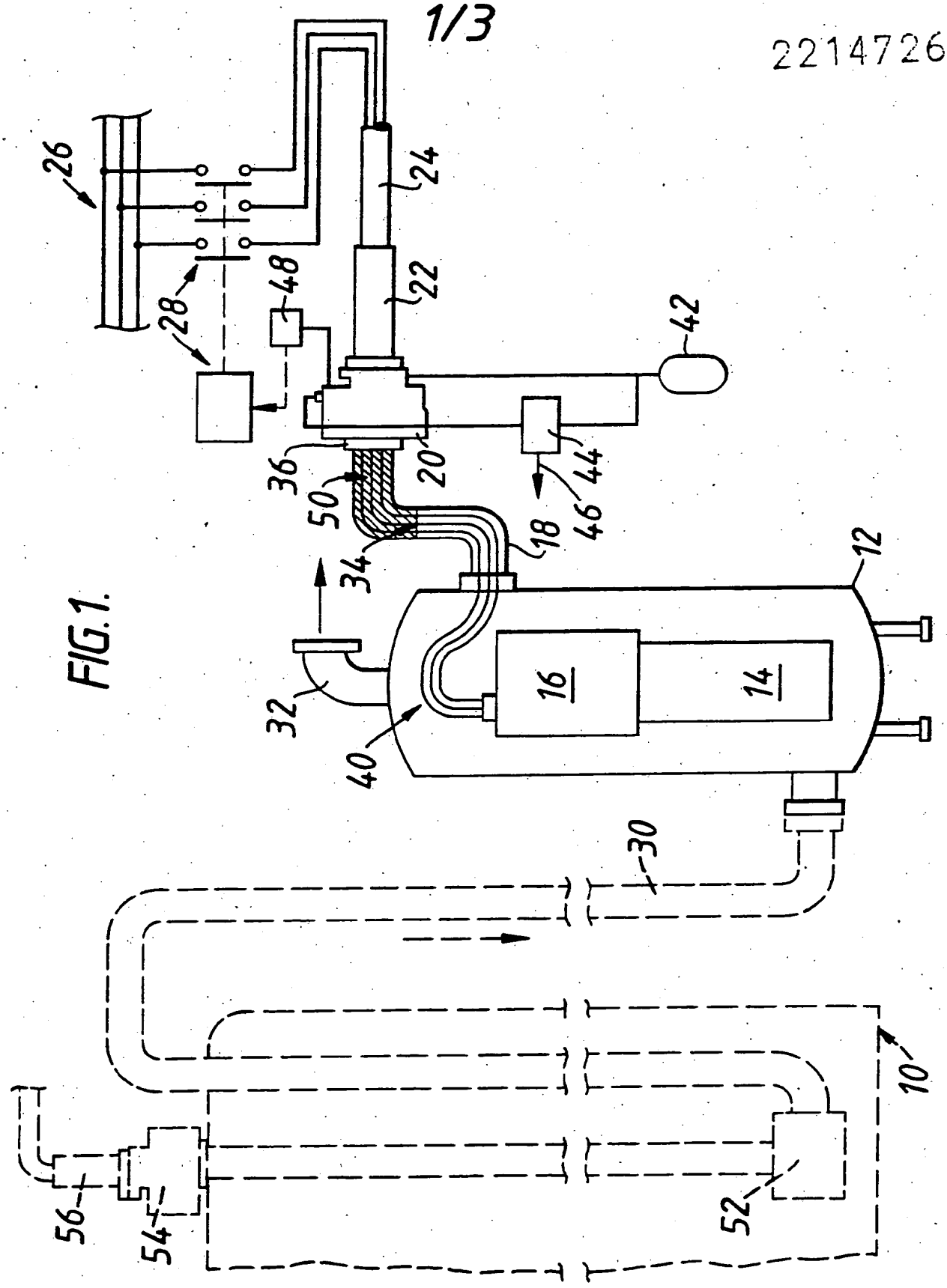

FIG.1.

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FIG. 2.

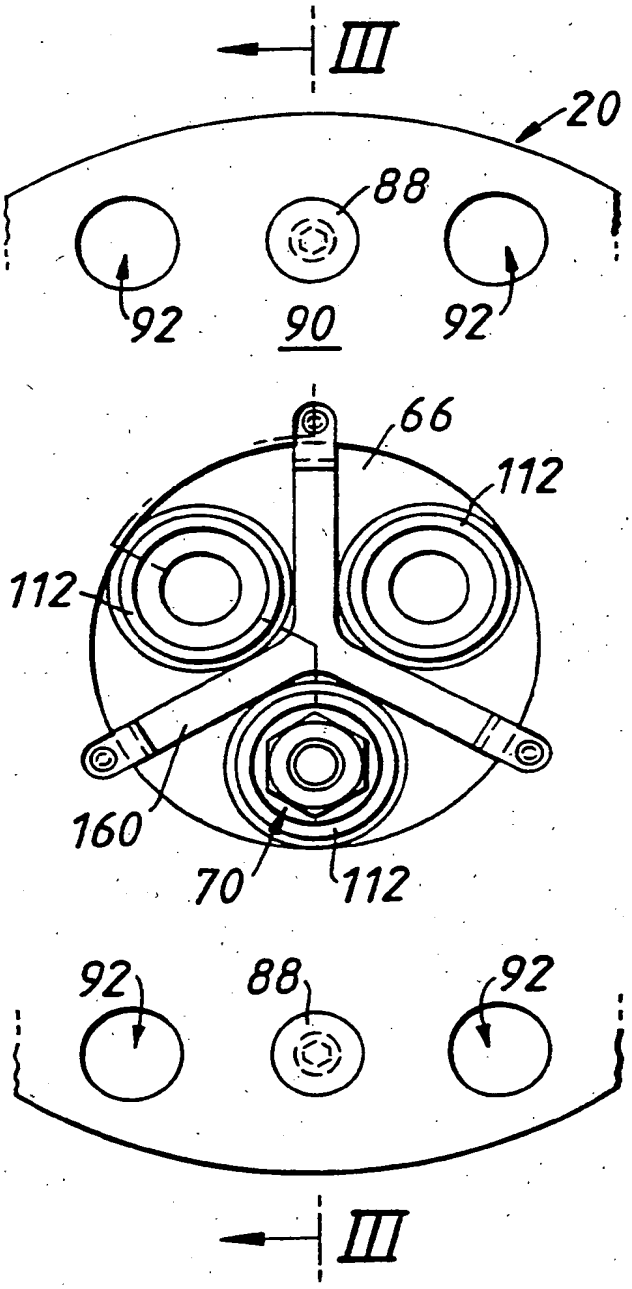

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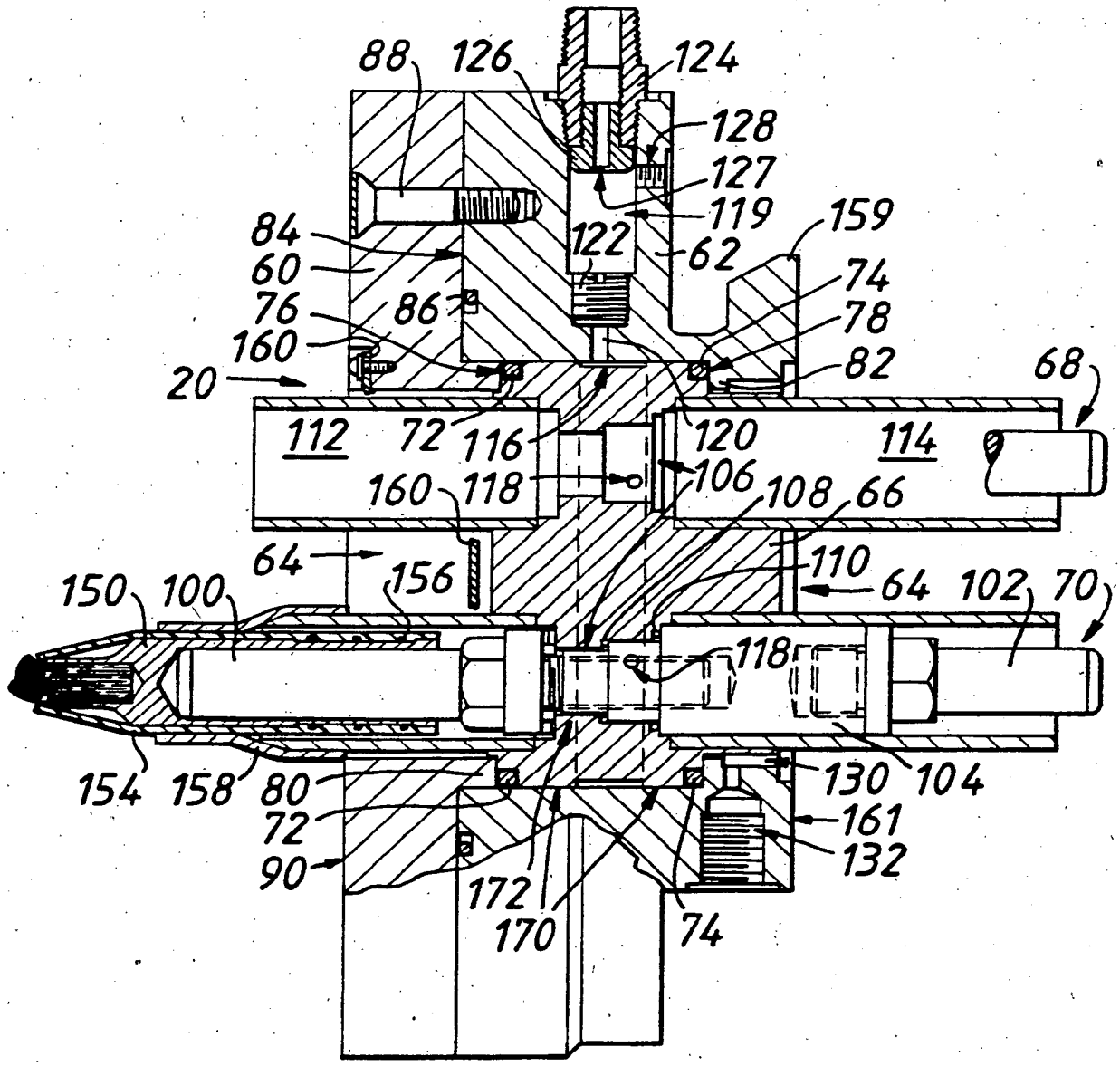
FIG. 3.



ELECTRICAL ADAPTOR

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The invention relates to electrical adaptors particularly though not exclusively to adaptors by which an electric supply can be connected to electric apparatus exposed to flammable fluid, whether it be a gas or a liquid.

An example of apparatus exposed to flammable fluid is a pump and its associated electric submerged in liquified natural gas contained in a pressure vessel. The means used at present to connect an electric supply to such a motor comprises a seal arrangement for connection to the pressure vessel and a junction box which contains electric conductors and to which an electric coupler is connectable. Nitrogen gas is passed continuously to purge the enclosure of natural gas which has leaked from the pressure vessel into the enclosure. It has been found that such apparatus has a serious drawback because it does not prevent leakage of natural gas beyond the enclosure to the electric supply, so giving rise to serious hazard.

It is an object of the present invention to provide an electrical adaptor in which a flow of an additional gas such as nitrogen for purging is unnecessary.

According to the invention, an electrical adaptor comprises a housing, an opening through the housing, a body of electrically insulating material in the opening, first annular seal means engaging the housing and the body, at least one passage extending through the body and through the first seal means, a respective conductor means extending through the

or each passage, respective second annular seal means encircling the or each conductor means and engaging the respective conductor means and the body, the housing presenting at one end an annular sealing face extending transversely of the conductor means and the body and the housing providing a path by which the or each passage communicates with the atmosphere outside the body, the first and second seal means being interposed between the sealing face and the path.

Preferably, the path comprises a recess which extend around the outside of the body and which is open towards the opening, holes extending through the body from the or each passage to the recess and an outlet extending through the housing from the opening to the outside of the housing.

Preferably, where the adaptor is in an arrangement for connecting an electric supply to electric apparatus exposed to flammable fluid in a containment, the path includes a restriction and the adaptor having a port leading from the path at a point between the restriction and the opening, the port being connected to pressure responsive means which if leakage flow of the flammable fluid past the first seal means exceeds a predetermined rate responds to a resulting pressure increase at the port to initiate isolation of the electric supply.

An embodiment of an adaptor will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a schematic diagram of a liquified natural gas (LNG) storage arrangment used by the Applicants incorporating the adaptor;

Figure 2 is a partial elevation of the adaptor incorporated in the arrangement shown in Figure 1; and

Figure 3 is a section on the line II-III in Figure 2.

Figure 1 shows the following principal components: a main storage tank 10 indicated in ghost outline; an auxiliary tank 12; a multistage centrifugal pump 14 and an electric drive motor 16 driving the pump 14 both mounted inside the tank 12; a swan-neck 18 connected to the tank 12; the adaptor 20 connected to the swan-neck 18; an electric coupler 22; and a cable 24 connecting the coupler 22 to a three-phase electrical supply 26 via a circuit-breaker 28.

The tank 12 contains LNG and is kept full by supply from the main tank 10 via a pipe 30. The pressure within the tank 12 is maintained by virtue of the delivery pressure at the top of the tank 10 (from the pump 52) plus the head of LNG within the pipe 30 which head for example is 12×10^5 pascals (12 bar). The submerged pump 14 supplies LNG to the point of use via a pipe which passes at 32 out of the tank 12. The tank 12 and the swan-neck 18 form a pressure vessel containment and the LNG has generally a free surface inside the tank 12 and inside the swan-neck 18 at the level indicated at 34 in the swan-neck. The swan-neck 18 terminates in a standard flange 36 which is in sealing engagement with a gasket (not shown) positioned between the flange 36 and a sealing face described below with reference to Figures 2 and 3 (see the face 90).

The flange 36 is preferably a Class 150 flange according to the specification of the American National Standards Institute (ANSI) at section B.116.5 for steel pipe flanges and flanged fittings.

The motor 16 is supplied via three phase conductors 40 which pass out of the tank 12 through the swan-neck 18 and are terminated by respective connectors which are push fits onto the ends of conductor means in the form of pins in the adaptor 20 described below. The opposite ends of the pins are connected to the push-on connectors in the coupler 22. Typically the coupler 22 is rated at 3.3 kilovolts, 300 amperes, three-phase.

The adaptor 20 is vented to a breather vessel 42 and the connections include a valve mechanism 44 by which instrument and test connections can be made to the adaptor via a connection point 46. The adaptor 20 has a port connected to pressure-responsive means 48. If pressure at the port should rise above a predetermined limit, owing to leakage of natural gas into the adaptor from the pocket of natural gas 50 in the swan-neck 18 above the surface 34 of the LNG, the means 48 initiates isolation of the supply 26 by tripping the circuit-breaker 28.

The main tank 10 contains a pump and electric drive motor combination 52 submerged in the LNG in the tank and forcing LNG up the leg of the pipe 30 within the tank. The motor is supplied via an adaptor 54, similar to the adaptor 20, connected to a coupler 56 by which the motor is connected to a cable loading to the supply 26.

Figures 2 and 3 show the adaptor 20 in detail. It comprises the following principal items:-

a housing made up of two parts 60, 62 preferably made of gun-metal for example defining a circular opening 64 which extends right through the housing and in which there is located a generally cylindrical body 66 of electrically insulating material; and three similar conductor means, two of which are shown at 68 and 70. Preferably, for example, the body 66 is composed of the woven glass epoxide laminate material available from Permali Gloucester Limited under their designation 22 FE 29. The planes of the laminations extend across the opening 64 vertically as viewed in Figure 3.

The body 66 has two annular, circumferential step-shaped portions which locate respective metal O-ring seals 72, 74 forming primary and secondary first seals, respectively, resisting leakage towards the coupler 22 and preferably, for example, of the kind available from Fothergill Engineered Polymers Limited of Bridgwater, Somerset. The seals 72, 74 are coated with polytetrafluorethylene and are compressed slightly between respective annular plane faces on the body 66 provided by the step-shaped portions and respective opposed annular plane faces 76, 78 on the housing parts 60, 62, respectively. The face 76 is at the end of an annular spigot 80 on the part 60 which locates, in the opening 64, in the part 66. The face 78 is the inner face of an inwardly-projecting, annular flange 82 on the part 62.

The housing parts 60, 62 have respective plane, annular faces held in mutual engagement at 84 with a metal O-ring seal 86 preferably of a kind similar to the seals 72, 74 located in an annular groove in the part 62 and compressed between the face at 84 of the part 60 and the base of the groove. Screws 88 secure the two parts 60, 62 together. The part 60 presents an annular plane sealing face 90 at which the seal mentioned above engages when the adaptor 20 is secured to the flange 36 (figure 1) by bolts (not shown) passing through holes 92 in the adaptor housing parts 60, 62 and through the flange 36.

Each of the three conductor means, two of which 68 and 70 are shown in Figure 3, comprise two end pins 100, 102 and a spacer 104. The spacer 104 has tapped holes in its ends which receive the respective screwed ends of the pins 100, 102. The spacer 104 has two reduced diameter parts so that two annular shoulders are provided which are opposed to annular shoulders between countersunk parts of a respective one of three passages 106 extending through the body 66. Metal O-ring seals 108, 110 are compressed between the respective annular shoulders on the spacer 104 and the body 66 in the passage 106. The seals 108, 110 are similar in construction to the seals 72, 74 and form respectively primary and secondary second seals resisting leakage towards the coupler 22.

Each passage 106 has countersunk end portions which receive the ends of respective tubular shrouds 112, 114, composed of electrically insulating material, preferably of the resin-glass fibre kind available from Permali Gloucester Limited under the designation 55, and glued in position.

The body 66 has an external circumferential recess 116 which is open to the interior of the opening 64 through the housing. Each of the three passages 106 through the body 66 communicates with the recess 116 via a hole 118.

The interior of the opening 64 and the recess 116 communicate with the ambient atmosphere around the housing via a radial bore 119 which increases in diameter stepwise as it extends outwardly. The innermost part of the bore of smallest diameter at 120 opens into the passage 64 at the recess 116. The next portion of greater diameter is tapped to receive a sintered metal plug 122 having an external screw thread. The next outward portion of slightly greater diameter has a flared and tapped end to receive a vent plug 124. The inner end of the plug 124 is tapped to receive a nipple 126, which has a head providing a restriction 127 in the form of an orifice preferably 1.0 millimeter in diameter and 0.5 mm in length. The vent plug 124 is connected by a tube to the valve mechanism 44 (see Figure 1). There is a tapped port 128 in the housing part 62 which opens into the bore 119. The port 128 is connected by a tube to the pressure-responsive means 48 (see Figure 1).

The housing part 62 is countersunk at 130 and the interior of the countersunk bore communicates with a tapped connection 132 in the housing part 62. The connection 132 is connected via a tube directly to the breather vessel 42 (see Figure 1).

The pins 100 receive respective copper female connectors 150 which are crimped to the ends of the respective phase conductors 40 leading to the pump motor 16 (see Figure 1). Each connector 150 has longitudinal slits (not shown) to define flexible fingers which yield to allow push fitting onto the pin 100. Each connector 150 is enclosed by an inner elastomeric sleeve 154 having an internal coil spring 156.

An outer elastomeric sleeve 158 is fitted around the end of the respective tube 112 and around the inner sleeve 154.

The housing part 62 has screw holes (not shown) in a flange part 159 to provide for the securing of the coupler (Figure 1) to the housing in engagement with the face 161 of the housing part 62.

Figure 2 shows a three-legged copper earthing conductor 160 extending between adjacent tubes 112.

OPERATION

Such very small normal leakage of natural gas which arises owing to flow past the O-ring first seal 72 or past any O-ring second seal 108 passes into the recess 116 from the interior of the opening 64. The flow then passes through the bore part 120, through the sintered plug 122 through the restriction at 127, and thence to atmosphere via the breather vessel 42 (Figure 1). Should the leakage flow become significant say greater than 1710 cubic centimetres per minute (3 cubic feet per hour) the orifice restriction 127 chokes the flow and the pressure in the bore 119

increases. At a predetermined value of 1000 pascals (10 millibar) the pressure is detected by the pressure-responsive means 48 (Figure 1) which initiates tripping of the circuit-breaker 28 to isolate the supply 26 from the pump motor 16 and also initiates operation of an alarm (not shown).

As a further safeguard which is not essential to the invention the adaptor described provides a second branch to the path to atmosphere for leaking gas via the connection 132. Any leaking gas which passes the secondary O-ring seal 74 or the secondary O-ring seals 110 is collected by the volume provided by the countersunk portion 130 of the housing part 62 and passed out via the connection 132 to atmosphere. No leakage into the coupler 22 (Figure 1) or along the cable 24 (Figure 1) is possible.

The sintered plug 122 and a further sintered plug (not shown) in a vent plug secured into the connection 132 provide flame traps. The clearances at 170 between the body 66 and the wall of the opening 64 and at 172 between each spacer 104 and the wall of its passage 106 are designed to have lengths and widths compatible with adequate flame paths. The adaptor is intended to be designed to meet the requirement for approved flameproof equipment.

The operation of the adaptor 54 indicated in Figure 1 would be similar to the operation of the adaptor 20 described above.

In some applications, each individual phase of the supply, for example where the currents passing are very large, has its own adaptor i.e. the adaptor has one conductor means for only one phase. The invention extends to adoption in such applications.

The valve mechanism 44 enables the connection at the vent plug 124 to be temporarily isolated from the breather vessel 42 (Figure 1) and connected via the point 46 instead to instrument and test means (not shown) for the purposes of testing and calibrating the adaptor.

The adaptor described above with reference to the drawings is typically, for example, rated to effect conection between the motor 16 and electric supply at 300 amperes, 3.3 kilovolts 3-phase, maintaining insulation between the phases and between each phase and earth in a temperature range of +100° Celsius to -163° Celsius up to a maximum working pressure of 20×10^5 pascals (20 bar). It typically passes a current of 280 amperes without incurring a temperature rise greater than 45° Celsius.

CLAIMS

1 An electrical adaptor comprising a housing

an opening through the housing

a body of electrically insulating material in the opening

first annular seal means engaging the housing and the body

at least one passage extending through the body and through the first seal means

a respective conductor means extending through the or each passage

respective second annular seal means encircling the or each conductor means and engaging the respective conductor means and the body

the housing presenting at one end an annular sealing face extending transversely of the conductor means

and the body and the housing providing a path by which, the or each passage communicates with the atmosphere outside the body

the first and second seal means being interposed between the sealing face and the path.

2 An adaptor according to claim 1 the path comprising a recess which extend around the outside of the body and which is open towards the opening, holes extending through the body from the or each passage to the recess and an outlet extending through the housing from the opening to the outside of the housing.

3 An adaptor according to claim 1 or claim 2 the path including a restriction and the adaptor having a port leading from the path at a point between the restriction and the opening.

4 An adaptor according to claim 1 or claim 2 each passage being coaxial with two tubular extensions of electrically insulating material having their inner ends fitted into and secured in respective countersunk ends of the passage.

5 An adaptor according to claim 1 or claim 2 the housing comprising first and second parts, the first part having an inwardly directed annular at one end of the opening, the second part providing the sealing face directed away from the first part, the second part having an annular spigot extending into the first part in the opening and the end of the spigot engaging the body, the two parts having respective annular surfaces which are parallel to the sealing face and which are forced together by securing means with an annular third seal means compressed between the two parts and with the first seal means compressed between the spigot and the body and between the body and the housing.

6 An adaptor according to claim 1 or claim 2 the or each conductor means comprising members interconnected by screw thread formations and further comprising a first and second oppositely directed annular abutments opposed respectively to third and fourth annular abutments provided by the body in the passage, the second seal means being compressed between the first and third abutments by relative screw movement of the members. The second and fourth abutments being mutually engaged.

7 An adaptor according to claim 1 in an arrangement for connecting an electric supply to electric apparatus exposed to flammable fluid in a containment the adaptor being fixed in relation to the containment with the sealing face in sealing relationship with the containment a respective conductive lead extending from the electric apparatus being electrically connected to one end of the or each conductor means and an electric coupler which is connected by a cable to the electric supply being secured to the housing at the end remote from the sealing face with a respective conductive contact of the coupler engaging the other end of the or each conductor means.

8 An adaptor according to claim 1 in an arrangement for connecting an electric supply to electric apparatus exposed to flammable fluid in a containment, the path including a restriction and the adaptor having a port leading from the path at a point between the restriction and the opening, the port being connected to pressure responsive means which if leakage flow of the flammable fluid past the first seal means exceeds a predetermined rate responds to a

resulting pressure increase at the port to initiate isolation of the electric supply.

9 An adaptor according to claim 1 substantially as herein described with reference to the accompanying drawings.

10 An adaptor according to claim 1 in an arrangement for connecting an electric supply to electric apparatus exposed to flammable fluid in a containment substantially as herein described with reference to the accompanying drawings.

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